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Fertilizing Corn

Cooperative Extension South Dakota State University

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Each bushel of corn will take up approximately 1.4 lb of nitrogen (N), 0.5 lb of phosphate (P_2O_5), and 1.2 lb of potash (K_2O), along with other essential elements. If soil reserves cannot supply adequate amounts of these essential nutrients, additional nutrients must be provided by fertilizer, manure, or legumes. Nitrogen, phosphate, and occasionally potash and zinc are most commonly deficient.

Recommended Fertilizer Rates

Several factors can affect fertilizer recommendations, however, the yield desired and existing fertility levels are the most important.

Soil testing is the best tool we have to measure available plant food levels. SDSU soil tests can measure organic matter, nitrate-nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, boron, zinc, salts, and acidity.

Soil sampling procedures are very important and vary between tests. Consult your county Extension agent for assistance and instructions for sampling. Information is also available in Fact Sheet 633 and on the back of the SDSU Soil Test Information Sheet.

Nitrogen

South Dakota soils have 2,000-5,000 lb of nitrogen per acre in the tillage zone. Yearly release of this nitrogen, however, is usually only 1 to 2% of that total. This is seldom enough to meet the needs of annual crops, and additional nitrogen may need to be applied.

Nitrogen deficiency in young corn plants is characterized by stunted, spindly growth and light green foliage. In older plants, nitrogen will move out of the lower, older leaves into newer, growing parts. The midrib area of these older leaves will become yellow near the leaf tip. This color change will extend up the midrib. The leaf may die prematurely, depending on the severity of the deficiency.

Nitrogen deficiency should not be confused with lack of moisture, which affects the upper as well as the lower leaves.

Nitrogen fertilizer recommendations will vary, depending on test levels found in the soil and yield desired (Table 1). The deep nitrate-nitrogen soil test is the most accurate tool on which to base recommendations. It should be taken from all fields being planted to non-legumes. It requires a sampling depth of at least 2 ft.

Table 1. Nitrogen recommendations

Yield goal		Soil plus fertilizer
Grain	Silage	nitrogen required[1]
bu/A	ton/A	lb/A-2 ft
40	5.0	38
60	7.5	67
80	10.0	96
100	12.5	125
120	15.0	154
140	17.5	183
160	20.0	212
180	22.5	241
200	25.0	270

[1] Fertilizer nitrogen to apply is equal to the value in the table minus soil nitrate-nitrogen to a 2-ft depth.

To estimate the fertilizer nitrogen needed without a 2-ft nitrate-nitrogen test, use the following formula based on the organic matter test. Required nitrogen minus 30, 45, or 60 lb for a low (less than 2.5%), medium (2.5-4.0%), or high (more than 4.0%) organic matter test, respectively. If the previous crop was black fallow, subtract an additional 45 lb from each category.

Nitrogen recommendations will be based on the less accurate organic matter test where deep nitrate samples are not available. The nitrate test is more accurate, however, because it can detect the wide variability in carryover levels of available nitrogen.

Legumes and manure will increase levels of available nitrogen. Test procedures presently used cannot measure these nitrogen reserves accurately, so the nitrogen recommendations in Table 1 should be adjusted downward accordingly. Guidelines for adjustments are on the back of the test report form accompanying recommendations returned to farmers.

Phosphorus

Total phosphorus in the tillage zone of South Dakota soils ranges between 1,000 and 2,000 lb/A. Only a small percentage of phosphorus, however, is readily available during the growing season. Failing to add phosphorus when the soil tests are low in this nutrient usually results in yield loss.

Phosphorus deficiency (young plants) is characterized by slow, stunted growth, purple colored leaves, and sometimes an unusually dark green color.

The recommended rates for phosphorus application are in Table 2.

Table 2. Phosphorus recommendations

Yield goal		Soil test phosphorus, lb/A				
		V. low	Low	Med.	High	V. high
		0-5	6-15	16-25	26-40	41 +
Grain	Silage	3	10	20	33	41
bu/A	ton/A	lb P_2O_5 recommended[1]				
40	5.0	22	21	17	0	0
60	7.5	34	32	24	0	0
80	10.0	47	42	32	11	0
100	12.5	59	53	39	14	0
120	15.0	72	63	47	18	0
140	17.5	84	73	54	21	0
160	20.0	97	84	61	25	0
180	22.5	109	94	69	29	0
200	25.0	122	105	76	32	0

[1] Recommedation listed for the center of each soil test range.

Potassium

Most South Dakota soils contain large amounts of potassium (35,000-50,000 lb/A in the plow layer). Research shows that few fields need added potassium to produce maximum yields. If tests are low, however, producers should not ignore recommendations.

Potassium deficiency symptoms include a slower rate of growth. Prolonged deficiencies result in leaf edges and tips becoming dry and scorched, with the rest of the leaf showing yellowish stripes, affecting the lower leaves first. Stalk lodging may also be greater where potassium deficiencies exist.

The recommended rates for potassium application are in Table 3.

Table 3. Potassium recommendations

Yield goal		Soil test potassium, lb/A			
		Low	Med.	High	V. high
		0-100	101-200	201-350	351 +
Grain	Silage	50	150	275	351
bu/A	ton/A	lb K_2O/A recommended[1]			
40	5.0	31	22	0	0
60	7.5	50	35	0	0
80	10.0	68	47	18	0
100	12.5	87	59	23	0
120	15.0	106	72	27	0
140	17.5	124	84	32	0
160	20.0	143	96	36	0
180	22.5	161	109	41	0
200	25.0	180	121	46	0

[1] Recommendations listed are for the center of each soil test range.

Zinc

Zinc levels range from 20 to 600 lb/A, mostly being unavailable to plants. Zinc does not leach from soils, and that which is returned in residue remains near the surface.

Zinc deficiencies are usually associated with soil that is severely eroded, sandy, low in organic matter, or where subsoil is exposed as a result of leveling for irrigation or terracing. Corn exhibits zinc deficiencies more readily than most other crops grown in South Dakota. Soil tests are very effective in detecting deficiencies of zinc.

Zinc deficiencies show up early, often when the corn plant is only 3 to 5 inches tall. Young corn plants exhibit broad yellow bands or stripes on both sides of the leaf midrib, starting near the base of the leaf but generally not extending to the tip, with the midrib and outer margins remaining green.

Zinc recommendations are shown in Table 4 and in fact sheet 674 entitled "Zinc deficiencies."

Table 4. Zinc recommendations

Corn	Zinc soil test (PPM Zn)		
	Low	Medium	High
	0-0.50	0.51-1.00	1.01+
	lb/A Zn recommended[1]		
Dryland	5	5	0
Irrigated	10	5	0

[1] Broadcast recommendation for inorganic zinc fertilizer (zinc sulfate), divide by 3 if chelate types are used. If band applied near the seed, divide recommendation by 2 and apply each year for 3 years.

Sulfur

Plant analysis has detected low sulfur levels in corn plants from some fields located on sandy soils. The use of sulfur, however, has not consistently increased crop yields, even though surface soil tests show low reserves. In many cases, deep soil tests (0-2 ft) show adequate available sulfur in the subsoil.

It is recommended that a deep soil test be taken before sulfur is applied. Information indicates the medium and finer textured silty or clayey soils usually have adequate sulfur.

Sulfur deficiency symptoms of corn appear on the young leaves as a light green to yellowish-green color. Close examination shows the tissue between the veins to be lighter green than the veins, and these stripes continue to the leaf tip.

Sulfur deficiency should not be confused with nitrogen deficiency. Sulfur shortages affect the entire plant, while nitrogen shortages show up on the lower, older leaves first.

Other Secondary Nutrients and Micronutrients

The other secondary nutrients and micronutrients such as calcium, magnesium, boron, copper, manganese, etc, are equally important. Because of adequate soil reserves, however, application of fertilizer containing these elements has not significantly increased corn yields. Farmers should use caution before investing in such programs.

Lime

Most South Dakota soils are near neutral or alkaline in the surface horizons and/or have free lime in the subsoil. SDSU research shows the use of lime has not consistently increased corn yields. Lime is seldom recommended.

Fertilizer for Irrigated Corn

Recommended fertilizer rates for irrigated corn can be found in Tables 1, 2 and 3 depending on yield desired and existing soil test levels.

Effective recovery of nitrogen by irrigated crops appears to be closely related to water management. Nebraska research shows nitrogen recovery from fertilizer can reach 80 to 85% if irrigators avoid applying water in excess of what is removed by evapotranspiration. Normal recovery the first year is considered to be 50 to 60%. Splitting nitrogen applications between preplant, sidedress, and injection can give improved results. Nitrification inhibitors may also improve results, particularily under sandy soil conditions.

Starter fertilizer placed near the seed can stimulate early plant growth under cool, moist conditions. Caution should be used with starter applications made in direct contact or very close to the seed.

Kinds of Fertilizer

Research indicates that the nutrients in gaseous, liquid, dry, and organic forms are equally effective. Cost, convenience, and application equipment become the determining factors in deciding which fertilizer to use.

Time and Method of Application

Fertilizer nutrients vary in movement and chemical activity in the soil, therefore time and method of fertilizer application can affect results. Phosphorus and potassium should be applied at or before planting time so they can be incorporated into the soil. Nitrogen can be applied or injected before and/or after planting.

Properly incorporated fall and spring fertilizer applications are equally effective. One exception is fall nitrogen application on sandy soils. Leaching losses of fall-applied nitrogen can become significant if excessive amounts of water move into or through the root zone. In those cases, nitrogen should be broadcast in the spring or sidedressed before final cultivation.

Nitrogen loss as a gas can also result from surface application of urea and urea-containing nitrogen sources such as UAN solutions. Losses can be significant during hot, dry weather. Incorporating the material soon after application will eliminate such losses.

Starter

Starter fertilizer placed near the seed at planting time can stimulate early plant growth. Research shows, however, that grain yield seldom increases. During unusually cool, wet springs, corn grain yield increases (3-5 bu) may be obtained from starter applications in the eastern third of South Dakota. During dryer years, yield decreases may occur.

Starter fertilizers may be applied in a number of ways, the most common being either banding 2 inches beside and below the seed or applied right with the seed (pop-up).

Caution should be used with starter applications that are placed in direct contact with the seed. Do not apply any nitrogen as urea or DAP (18-46-0) in contact with the seed. Limit other forms of nitrogen plus K_2O to 8 lb/A with the seed for 36-inch rows. If starter fertilizer is placed 2 inches beside and below the seed, chances of germination and seedling injuries are extremely small.

Farmers are cautioned against applying high levels of phosphates at seeding time. Research shows yield reductions can occur when phosphate rates, applied as a starter, exceed 30 lb actual P_2O_5/A. Splitting applications of recommended phosphorus rates that exceed 30 lb/A is perhaps the best way to avoid yield loss.

Fertilizing Reduced and No-Till Corn

Some adjustments in fertilizer rates and placement may be necessary when reduced or no-tillage is used. As tillage is reduced, available nitrogen is also reduced. The deep (0-2 ft) nitrate-nitrogen soil test will measure this fluctuation and allow accurate nitrogen recommendations. When very reduced or no tillage systems are used, however, it may be necessary to add 30 lb of nitrogen to the recommendations made in Table 1 to obtain maximum yields.

If the deep soil test for nitrate-nitrogen is not taken and nitrogen recommendations are made using the less accurate organic matter test, recommendations should be increased by 60 lb/A from the calculated values.

Surface residues and fewer opportunities for incorporation increase the potential for volatilization losses from surface applied urea containing fertilizer with reduced tillage. In addition, tie-up of nitrogen may occur, therefore, incorporation of nitrogen fertilizer with limited tillage or injection result in more efficient nitrogen use.

Topdressed phosphorus fertilizers will remain near the soil surface with reduced and no-tillage systems. If soil test levels are low or conditions are dry, deeper incorporation, injection, or starter applications may be necessary.

As tillage is reduced, increased surface residues result in cooler soil temperatures and wetter soil conditions in the spring. Starter phosphorus applications will likely increase early corn plant growth.

Phosphorus-Induced Zinc Deficiency

Under certain conditions (low to medium soil test zinc and/or high soil phosphorus levels) the use of phosphorus as a starter fertilizer has induced zinc deficiency. To avoid this, do not exceed 30 lb P_2O_5/A in a band near the seed or as a pop-up at planting time. Correct zinc deficiency according to soil test recommendations.

Correcting Corn Growth On Fallowed Soils

Farmers and researchers have observed for some time how corn frequently fails to make normal early growth on soil that was fallow-tilled part time or all through the previous year. The reason for this early suppression of growth is not fully understood.

Tests show that banding phosphate at planting time has successfully corrected most early growth suppression on fallow fields, but has not consistently increased yields.

Post-emergence fertilizer application of phosphate and potash have not been effective. To avoid poor early corn growth on fallowed land, apply about 30 lb P_2O_5/A as a starter fertilizer. Observe earlier cautions concerning rates of starter fertilizer placed in direct contact with the seed.

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